High Latitude Survey Strategy

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Roman Community Workshop

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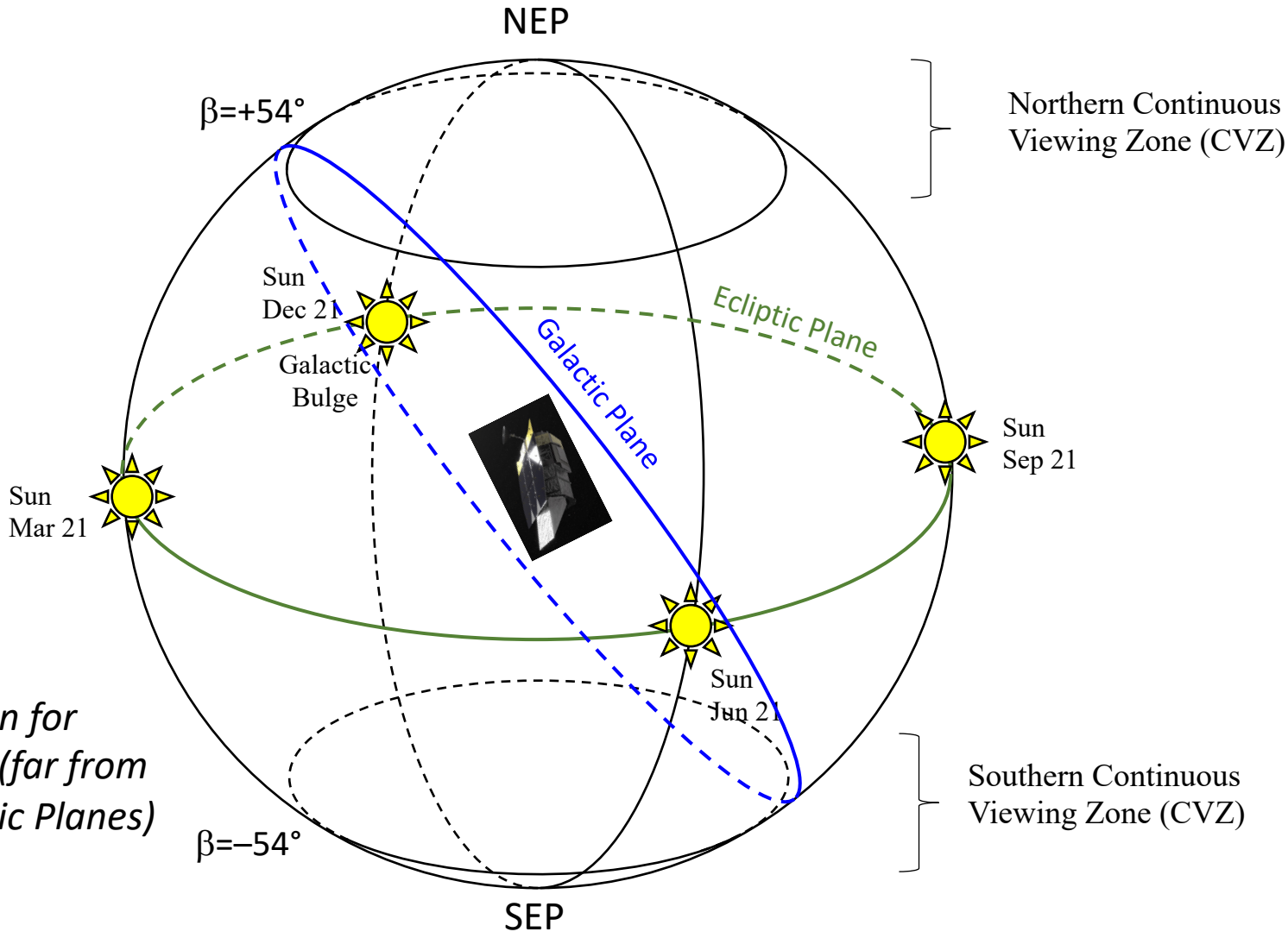
Overview

1. Roman WFI field of view & constraints
2. Reference survey strategy
   - *Designed as an example to show Roman meets its science requirements.*
   - *The survey that Roman really carries out could look very different.*
3. Alternative survey concepts

Pointing Considerations:

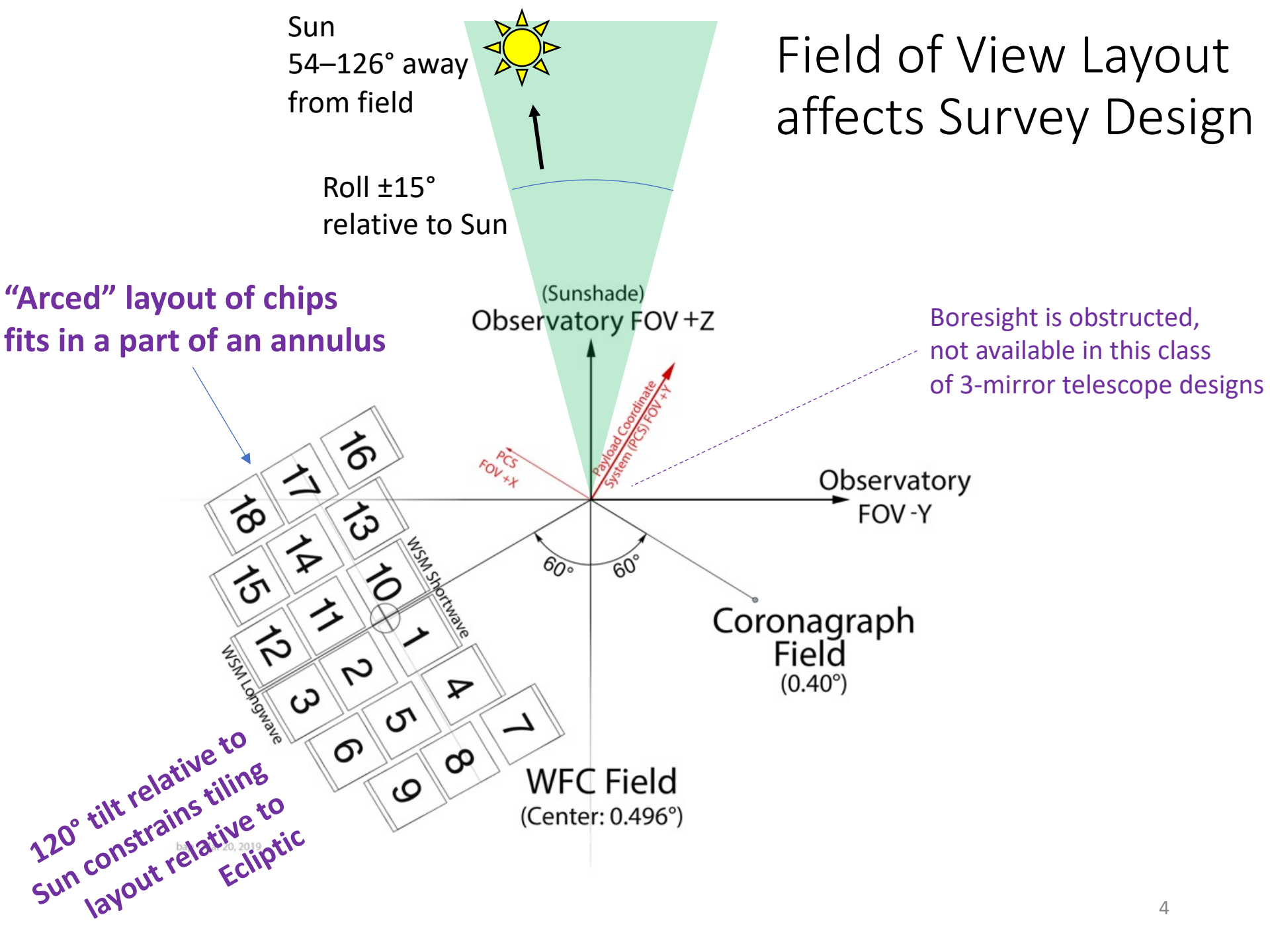
- Roman points 54—126° from Sun
- L2 orbit → no Earth, minimal Moon constraints

Cartoon version in Ecliptic Coordinates



Southern region for Reference HLS (far from Ecliptic, Galactic Planes)

Field of View Layout affects Survey Design



"Arced" layout of chips fits in a part of an annulus

Boresight is obstructed, not available in this class of 3-mirror telescope designs

120° tilt relative to Sun constrains tiling layout relative to Ecliptic

High Latitude Imaging Survey

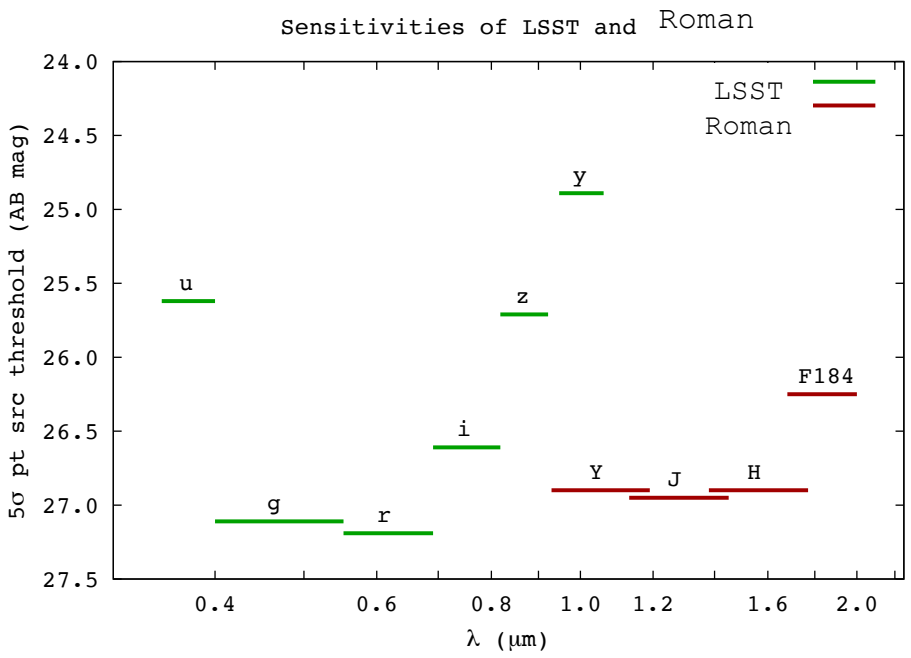
- Main driver for the reference survey was weak lensing. Basic needs are a wide area survey with:
  1. Angular resolution (+ well understood PSF) for shapes
     Constrained by 2.4 m aperture
  2. Depth (may trade with area)
  3. Near IR photometric coverage (from space)
     + need visible data from ground for photo-z's (Rubin/LSST or HSC)
  4. Internal cross checks

  A choice [Astro2010 guidance] was to do the shapes in NIR, and optimize the pixel size for J & H bands. Of course the pixel size of 0.11 arcsec is now a hard constraint.

- Additional data:
  - ❖ Deep fields used to understand noise effects in shallower survey.
  - ❖ Spectroscopic data to calibrate photo-z's.

HLIS Reference Survey Design

- Choose bands from Y band (Rubin coverage) to 2 μm (beyond which background would increase dramatically).
  - Reference Survey did not plan to use the visible filters for the wide survey as Rubin/LSST is providing the necessary depth.
  - This pre-dates the K_s filter.
- Shape measurement with J & H (primary) + F184.
  - Y band is most challenging for shapes due to sampling & wavefront. We intend to do shapes in Y on a best-effort basis, requirements are set for J & longer λ.
  - F184 is 0.7 mag shallower than H.
- Depth vs. area trade depends on how you tile the sky.

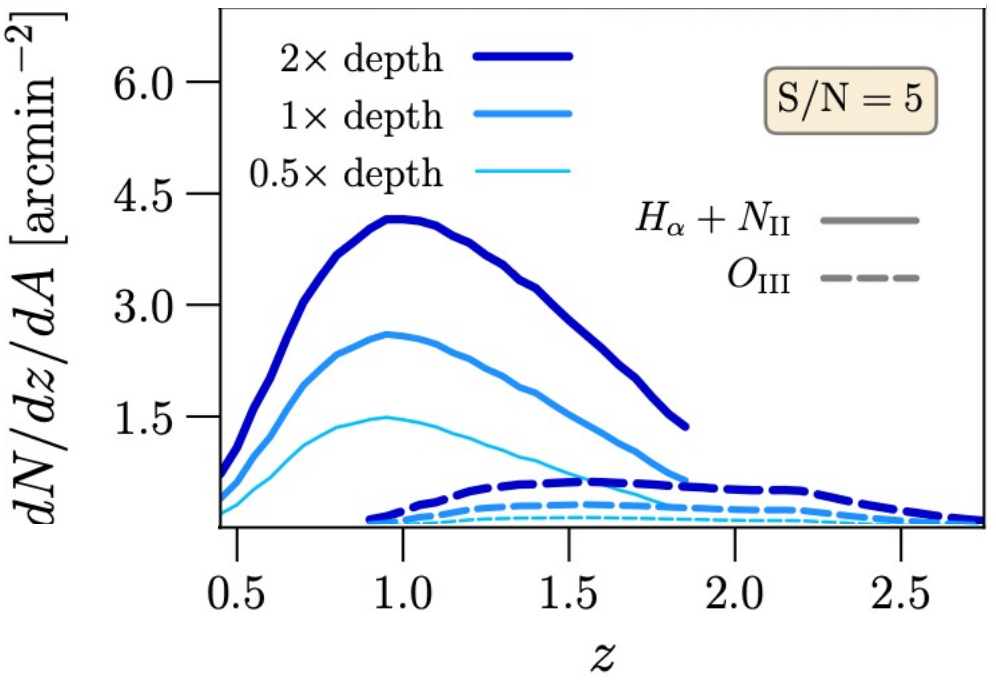


Reference survey:
Shapes n_{eff} = 50 galaxies/arcmin^2
(35 in H-band only)

High Latitude Spectroscopic Survey

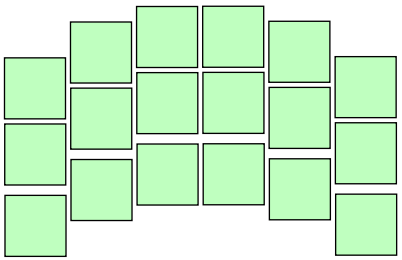
- 7 months / 2000 deg^2 of HLSS in Reference Survey. 4 passes at different roll angles, (6—8) x 297 s exposure time.
- Astro2010 version of this survey had a wide/shallow tier as well – Roman could do this, but might not be the best use of resources since the wide z~1 survey science is well covered by DESI + Euclid.
- Sensitivity of 7x10^{-17} erg/cm^2/s for a point source in the center of the band (can be a few times higher for extended sources like galaxies).
- 14M Hα redshifts & 3.6M [O III] redshifts in the Reference Survey
(3M redshifts per month)
- Eifler et al. (2020) explores depth vs. area trade and implications for cosmological constraints.

Grism: wavelength range 1.00—1.93 μm

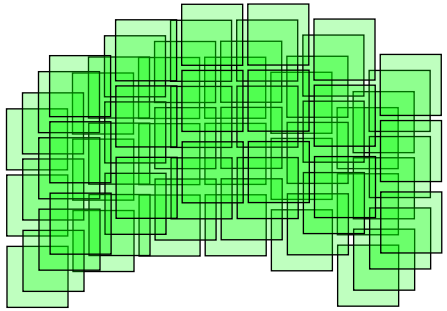


Eifler et al. (2020)

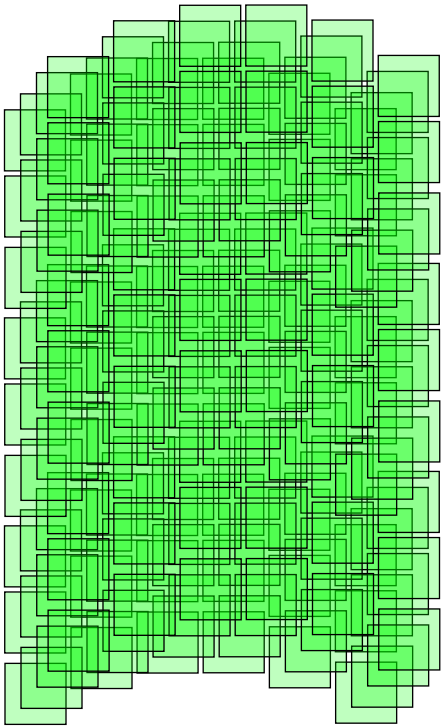
Example Tiling



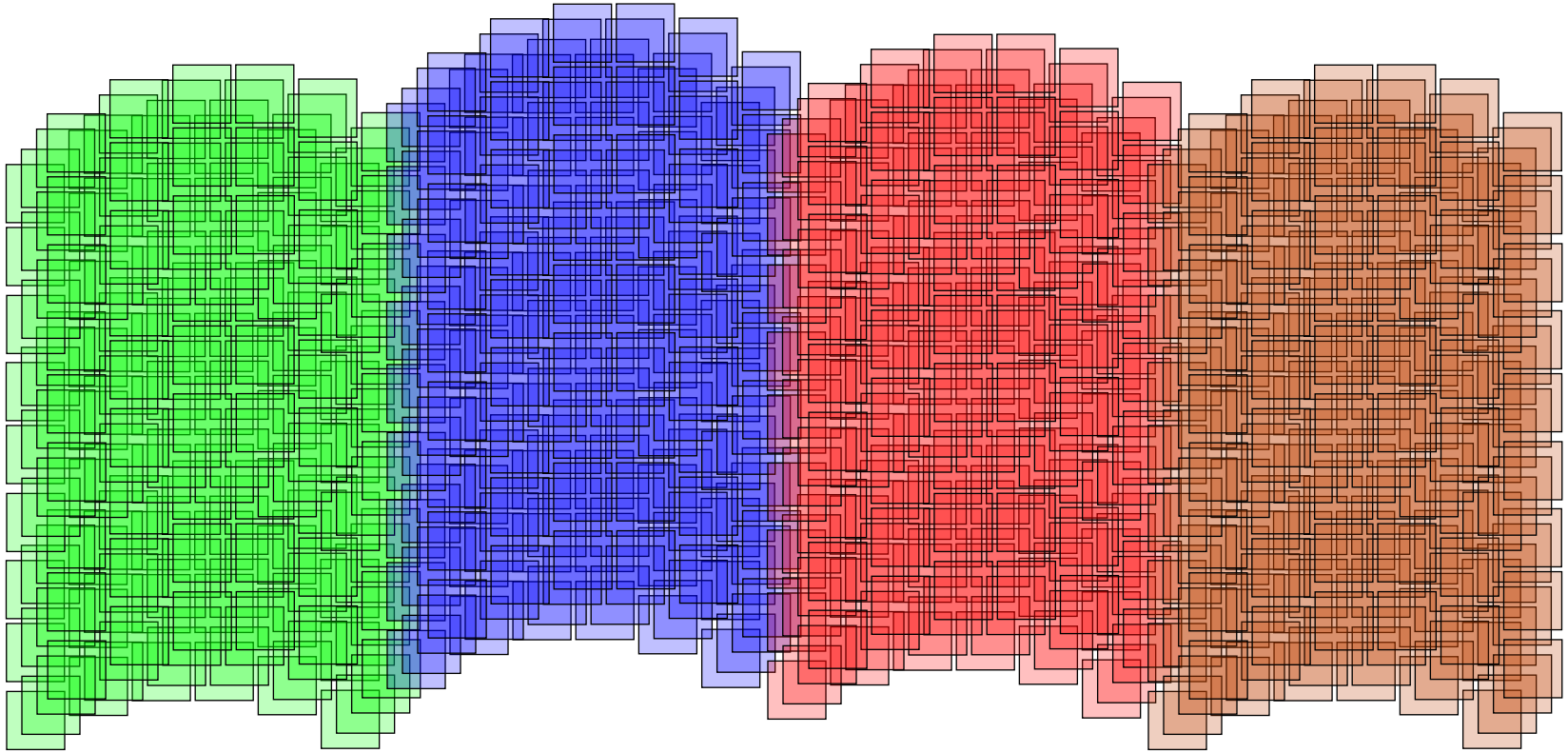
Example Tiling



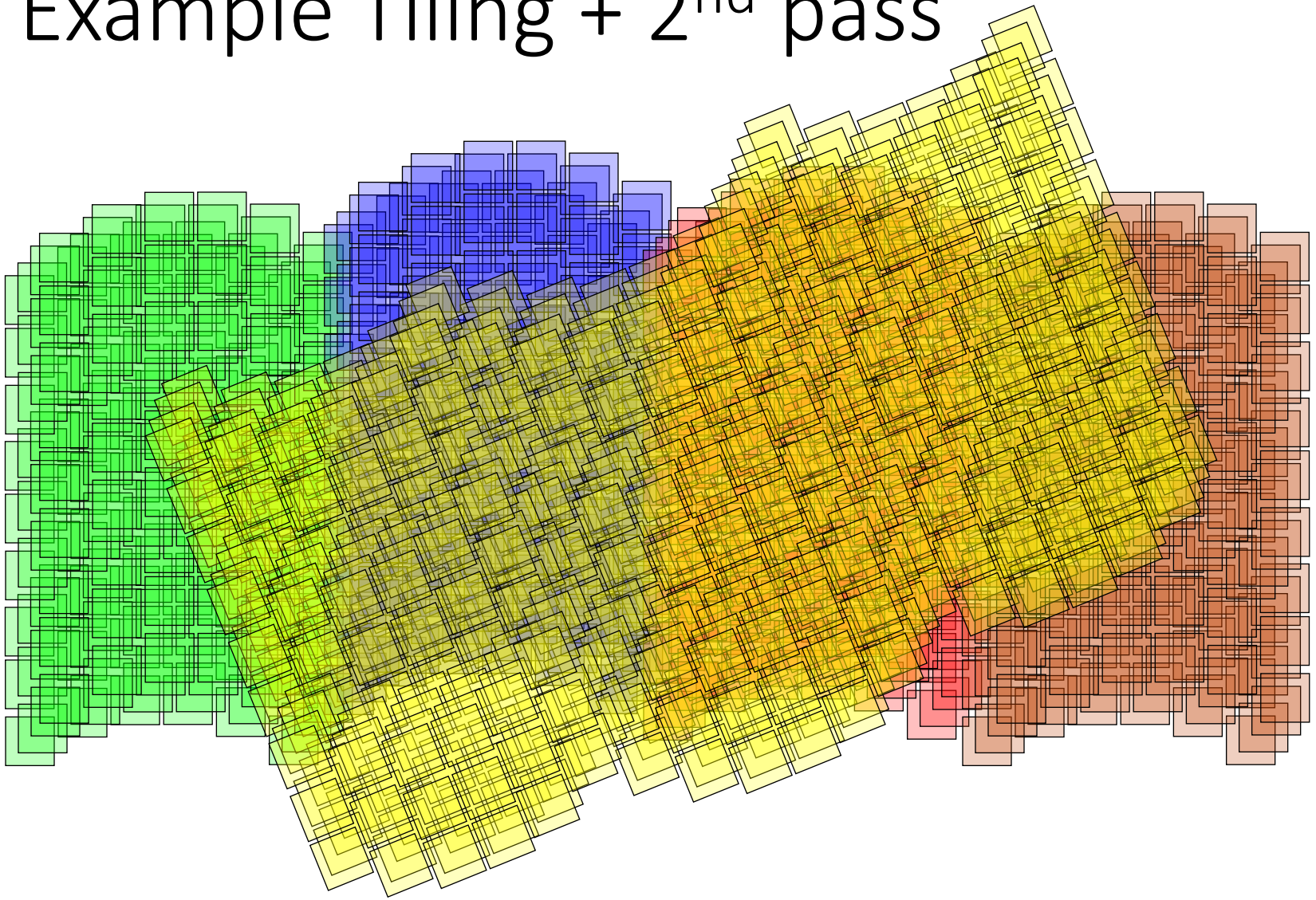
Example Tiling



Example Tiling



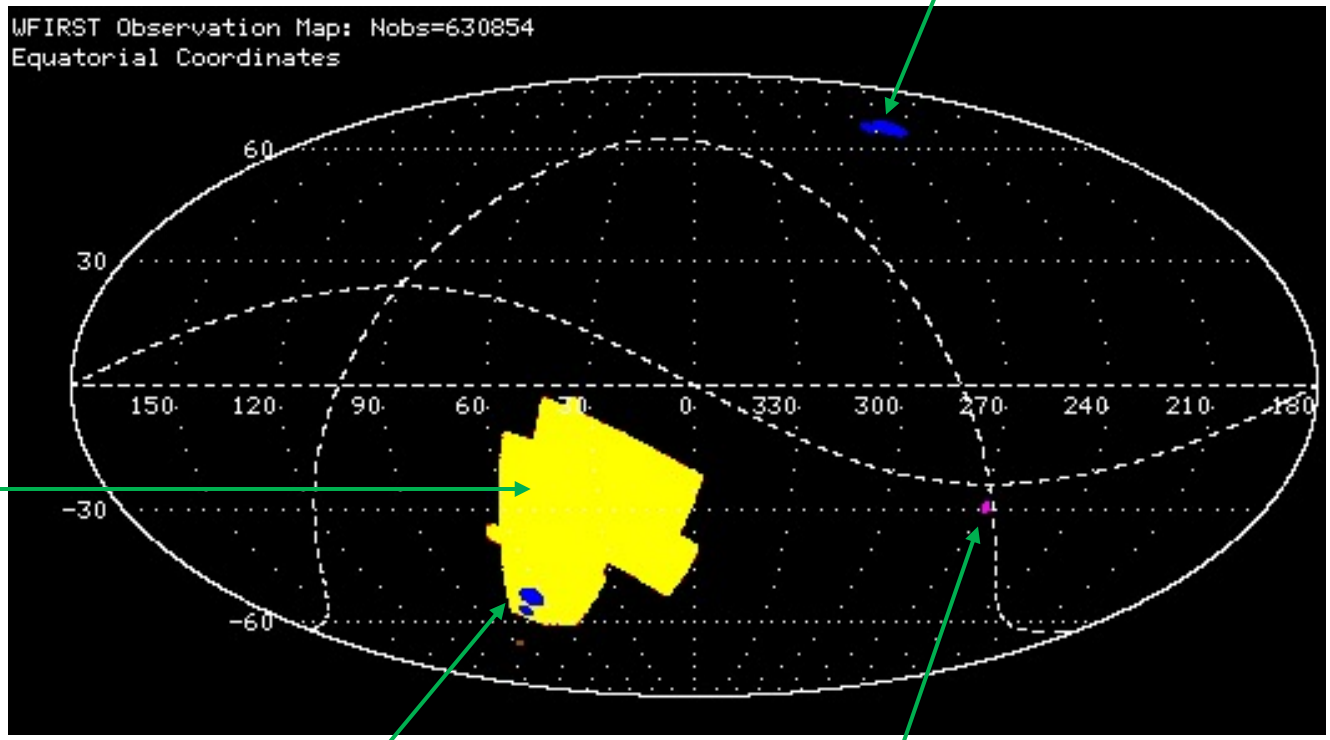
Example Tiling + 2nd pass



2nd pass (yellow) must be done at a different time of year if rotated by a large angle

Possible Placement

(from an integrated tiling simulation)



HLS Time Domain North

HLS Reference Wide Area (2000 deg^2)

HLS Time Domain South

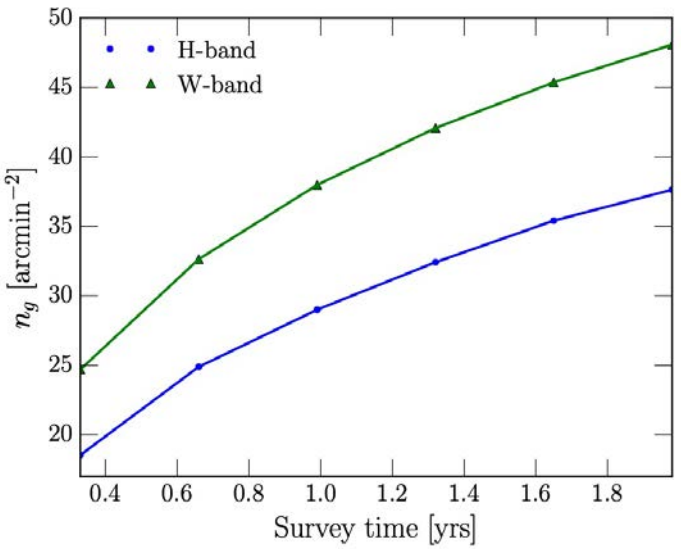
Galactic Bulge

Equatorial Coordinates; dashed lines show Ecliptic & Galactic Plane

Proposal for Very Wide Survey

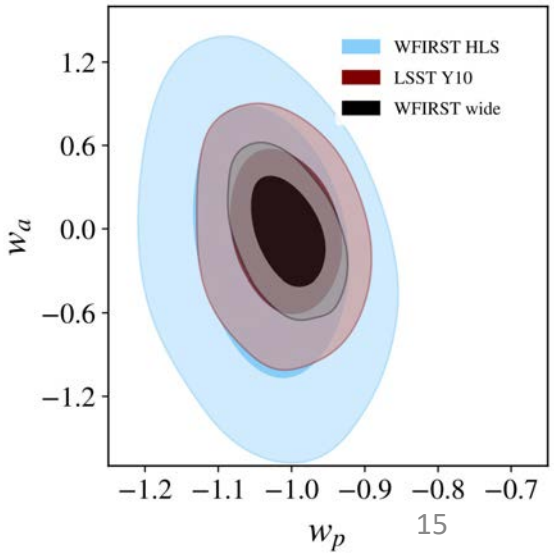
Suggestion to cover the Rubin footprint in wide (microlensing) filter
(Eifler, Simet, Krause et al. 2020)

- 18,000 deg^2 per 1.5 years
- Similar concept to the large survey with Euclid-VIS, but with a NIR filter
- Enormous statistical constraining power …
- but won't by itself provide the internal checks that we need, or as good of photo-z information at z>1

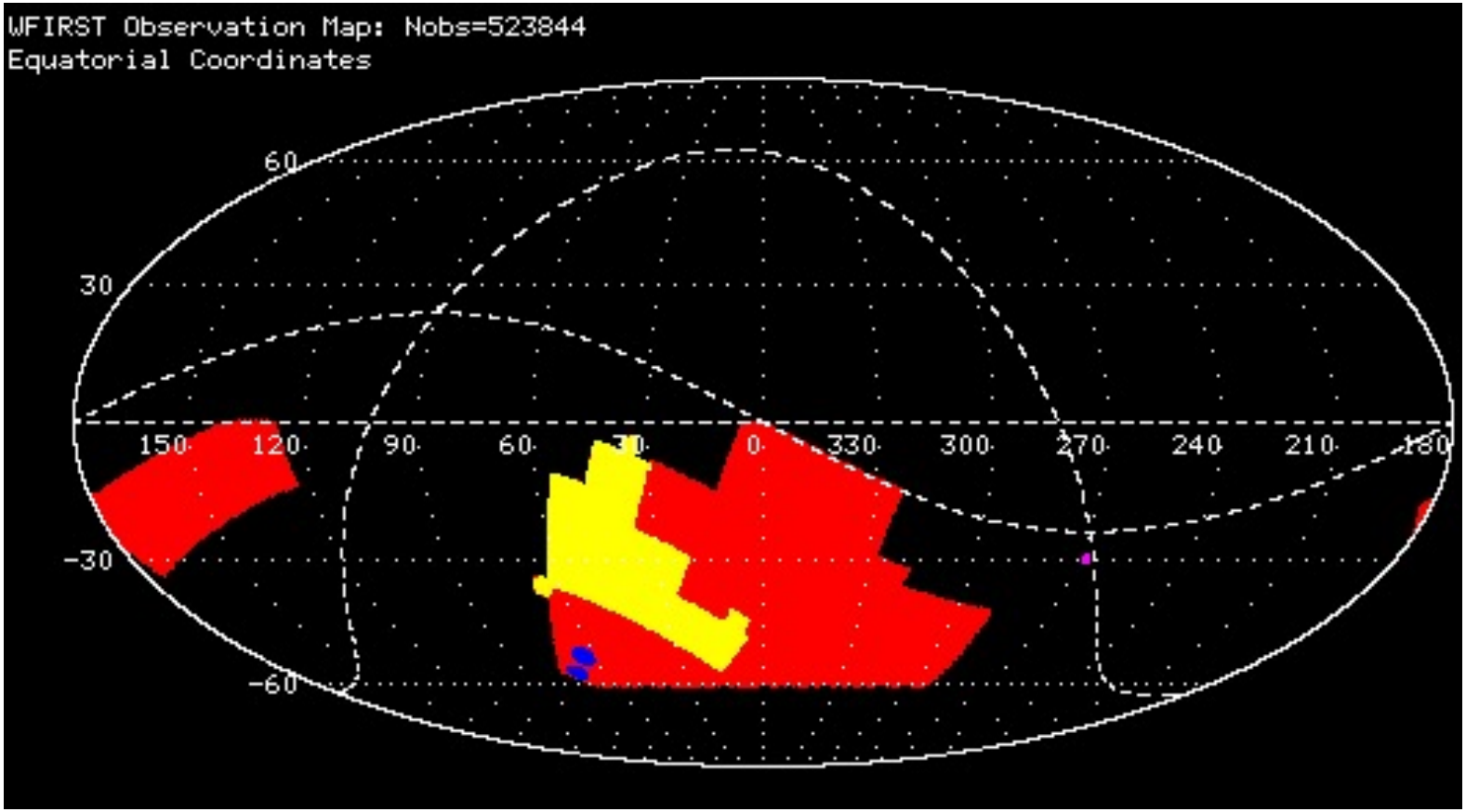


Considerations:

- Two tier strategy?
- How much Reference vs. Wide to do in the 5-year primary mission?

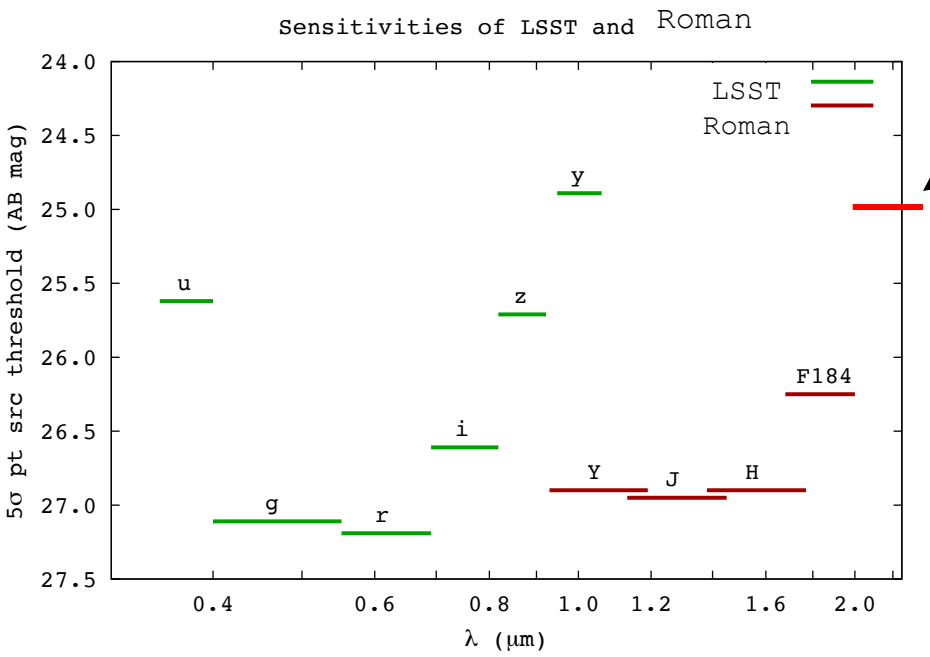


Multi-tiered surveys?



This example had an H band only survey (red, 5000 deg^2) with Y/J/H/F184/grism coverage in a smaller region (yellow).

K band?



K band at same exposure time
25.0 mag (5σ pt src)
~2 mag shallower for extended src shapes
n_{eff} = 12 gal/arcmin^2

- K band filter (1.95—2.30 μm) added in late 2020.
- I've shown where this lands with the same exposure time as the other filters. +4 months to observe 2000 deg^2.
- Due to thermal background, probably can't compete with H for shapes. But might do a part of the survey to higher depth to cross-check shape measurements with a PSF that is better sampled? Or for other survey science?

Final Thoughts

- There is a reference High Latitude Survey for imaging and spectroscopy.
  - Used for setting science requirements, and presented at our reviews up through CDR.
  - Ultimately traces back to Astro 2010 science objectives.

- However, the trade space for the survey we execute remains open.
  - Area/depth, multi-tier, which filters, footprint placement …
  - Total observing time is a constraint. What to do in 5-year primary mission?